

VOLCANOLOGY

Project title: **Eruption Observation of Selected Remote Geysers**

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Objective: To obtain eruption interval and eruption duration measurements of selected remote geysers at Shoshone Geyser Basin (Double Geyser, Frill Spring); Gibbon Geyser Basin (Phoenix Geyser, Oblique Geyser); Heart Lake Geyser Basin (Glade Geyser, Rustic Geyser); and Lone Star Geyser Basin (Buried Geyser, unnamed geyser southwest of bridge).

Findings: Shoshone Geyser Basin: Double Geyser erupted every 3,349-4,209 seconds (mean of 39 intervals = 3,610 sec); Frill Spring erupted in series every 4.2-5.6 days (five intervals obtained), series lasting 7-11 hours and consisting of 34-43 individual eruptions at somewhat regular intervals. Gibbon Geyser Basin: Phoenix Geyser erupted every 5,817-8,179 seconds (mean of 140 intervals is 6,870 seconds. Heart Lake Geyser Basin: Glade Geyser erupted every 15,882-34,485 seconds (mean of 20 intervals = 24,985 seconds). Lone Star Geyser Basin: Buried Geyser erupted roughly every 9-11 minutes, long-term variations noted during July; unnamed geyser southwest of bridge erupted at irregular intervals of one to many hours.

Project title: **Contemporary Surface Deformation of the Yellowstone Caldera**

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Objective: The fact that the Yellowstone caldera is deforming at geologically rapid and time-variable rates has been known for several decades, but the nature of the deformation source is still not well understood. This project aims to collect data on changes through time in the rate and pattern of surface deformation in order to further constrain models for the deformation source(s) beneath the caldera. These models, in turn, are being used to refine our assessments of volcanic and earthquake hazards within the park. Three different geodetic techniques are used: 1) precise leveling surveys along roadways every few years; 2) continuous Global Positioning System stations at several key sites; and 3) interferometric synthetic aperture radar (InSAR, a remote sensing technique) mapping each year when data are available.

Findings: We know from repeated leveling and GPS surveys that the surface of Yellowstone caldera has been deforming at rates of 1-3 cm/yr since the early part of the twentieth century. We also know that the deformation pattern changed from net uplift during 1923-1984, to steady subsidence during 1985-1995, and back to uplift starting in 1995. Various models indicate that the deformation source is located between 3 and 8 km beneath the surface. A satellite radar interferometry study published in 1999 revealed the presence of two deformation sources, apparently associated with two resurgent domes within the caldera. An important unresolved issue is the nature of the deformation source. Alternatives include pressure changes in the deep hydrothermal system beneath the caldera or movements of magma in the upper part of Yellowstone's active magmatic system.

Project title: **Measurement of Geothermal Water Temperatures at Hot River/Boiling River**

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Objective: Monitor the temperature of the geothermal flow into the Gardner River at Boiling River.

Findings: Preliminary data only.

Project title:	Study and Monitoring of Selected Geyser Activity
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Objective: Study the activity of selected geysers in the Upper Geyser Basin and West Thumb Geyser Basin to determine the activity patterns during the study period. This information will provide baseline activity data for these geysers.

Findings: In the summer of 1999, seven electronic recorders were maintained on the geysers that were monitored in 1997 and remained active. Data was recorded for all eruptions between July 7 and October 13 for all of the monitored geysers; in a few cases instrument failure caused loss of some data. The summary below shows the number of years of data that are available. The monitored geysers were: Geyser Hill: Aurum Geyser (3 years), Depression Geyser (3 years), Lion Geyser (2 years), Little Cub Geyser (2 years), Plate Geyser (2 years). Upper Geyser Basin: Pyramid Geyser (5 years). West Thumb Geyser Basin: Lone Pine Geyser (3 years).

Software was created to analyze the temperature records and detect all eruptions. For some geysers, duration is also detected; not all of these geysers have eruption characteristics that allow the duration to be determined from the temperature trace. The data collected spans an eruption of Giantess Geyser on August 23, 1999, and affords an opportunity to determine whether there is a connection between Giantess and the geysers being monitored. There is clear evidence of a connection between Giantess and Plate Geyser and Little Cub Geyser. The Plate Geyser connection was well known, but the Little Cub connection is less well documented. There is less definite evidence for an effect on Aurum, Depression, and Lion Geyser.

Other periodic or cyclic patterns in the eruptions are evident, and are strikingly different from those detected in 1998. Further analysis is required to determine what correlation may exist between the interval patterns of these geysers. Basic statistical and graphical analysis has been completed and the graphs have been made available to the park's interpretation division. Data from direct visual observation for many hours for the Geyser Hill geysers is also being analyzed. The intent is to create detailed descriptions of the activity of each of the monitored geysers in the final report. Pyramid Geyser continued to be a consistent feature with intervals around three hours. Lone Pine Geyser was less variable this year; in 1997 and 1998 there were numerous long (18-19 hour) intervals that punctuated the usual 16.5 hour intervals. In 1999, after a period of short (15 hour) intervals in June, the intervals stabilized at 16.5 hours and had only a few long intervals.